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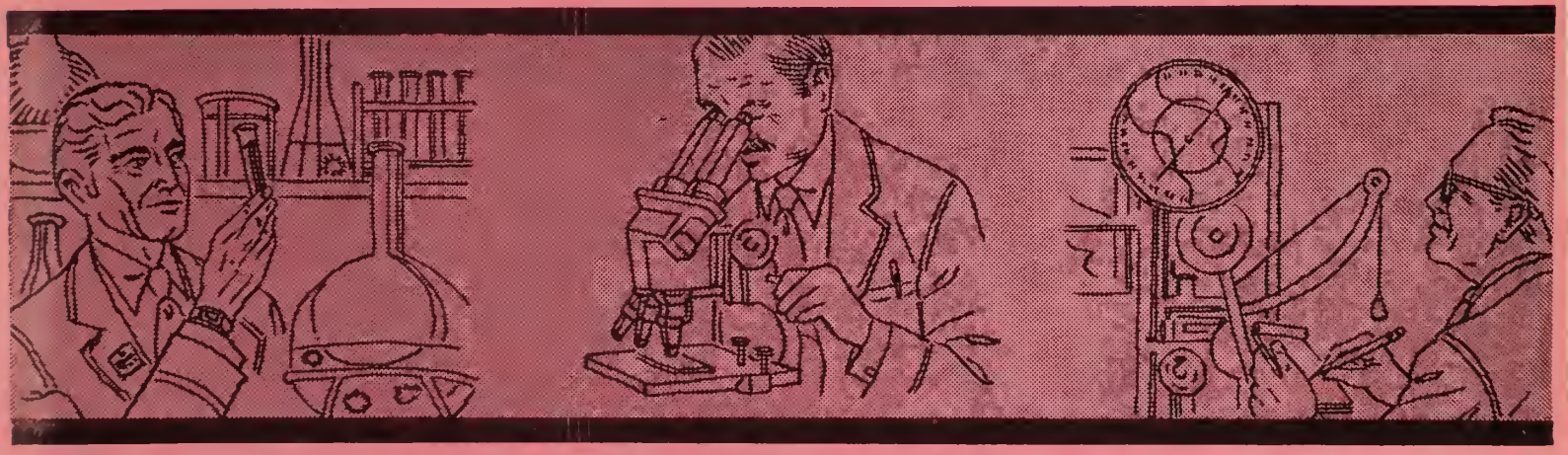
REPORT ON RESEARCH ACTIVITIES



COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS

Research and Materials

COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC WORKS

REPORT ON RESEARCH ACTIVITIES

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The Commonwealth of Massachusetts
Department of Public Works
Research and Materials Section

REPORT ON RESEARCH ACTIVITIES

Report No. Q-003 Date: 1 October 1969

This report has been prepared to present a brief abstract of some of the research activities being conducted by or sponsored by the Department.

If additional information should be desired on any research project, contact either the Research Engineer or the study Technical Representative.

John J. Lyons
Research and Materials Engineer

PART I SPONSORED RESEARCH

Study No. R5-0 - Roadside Development

Research Agency: University of Massachusetts

Research Supervisor: Assoc. Prof. John M. Zak

D.P.W. Tech. Representative: Joseph L. Beasley

Project Scope: Determine and develop the most practical and economical utilization of new and available materials for providing an attractive stable and readily available cover for varying roadside locations throughout the Commonwealth.

Progress during quarter

A. Sub-project R5-1 Use of grasses, mulches, and woody perennials for rapid stabilization of roadsides.

1. Grasses and Mulches: Plots using seven grasses have been established on a gravelly fill slope to evaluate rapid establishment for erosion control. Tree and shrub seeds of six species were planted in one of the replicates.

Scarified seeds of Siberian pea shrub, gray birch, and black locust which were planted in the growth chamber showed good germination and growth. Two methods of acid treatment on seeds of Bearberry failed to induce these seeds to germinate. Bayberry seeds soaked in ether to remove wax and then stratified gave 68% germination as compared to 28% germination for seeds whose surface wax was removed mechanically and then stratified.

2. Direct Seeding of Shrubs and Trees: Randomized plots were established to evaluate the use of various mulches and slow release fertilizers for transplanting shrubs and trees on a gravelly fill slope.

B. Sub-project R5-2 Development and evaluation of low maintenance herbaceous material for plantings along highways.

Plantings of potted plants and bare rooted crowns of crownvetch were made in the eight highway districts on Massachusetts. A few potted plants of Cicer milkvetch were also included. Lime and fertilizer amounts were used according to results obtained from greenhouse studies of crownvetch. Dormant seedings of crownvetch with the use of various companion crops show adequate crownvetch plants in each mixture for a successful planting.

A date of seeding of crownvetch experiment is in progress and the results look good. The purpose of the experiment is to determine the best time to seed crownvetch under Massachusetts condition.

Plots using crowns and potted plants of crownvetch were established on a deteriorating fill slope to determine the best method of establishment for bank cover. Some damage was done by accidental herbicidal spray along the guardrails.

In the experiment regarding breeding for a short strain of Kentucky 31-tall fescue, some 6000 seedlings from irradiated seeds were transplanted into a nursery. Irradiated seed was also seeded in the field. The transplants of Kentucky 31-tall fescue show a tremendous variation in the commercial strain of tall fescue.

C. Sub-project R5-3 Establishment of woody plants along roadsides to reduce functional maintenance costs.

Applications of dichlobenil made early December 1968, are giving excellent control of perennial grasses in Spring 1968, plantings of small juniper, bittersweet, pine and yew on State highway #10 in Bernardston.

Three major experiments were put on a large east-facing slope on I-91 involving the establishment of small woody plants. One experiment is a study of the effects of perennial grass competition on establishment of woody transplants; another experiment is to compare the survival of plants set bare-root as compared with transplanting in root-through pots; a third experiment is an evaluation of three slow release fertilizers, applied at the time of setting.

Six species of plants were used in these experiments.

D. Sub-project R5-4 Control of vegetation along guardrails by the use of chemicals.

Several soil sterilants were sprayed along guardrails for evaluating the control of vegetation. Excellent results were obtained with AAtrex, Hyvar X, Pyamitol 25E, and Atratol 8P.

Study No. R-9 - Hydrologic Study - Small Watersheds

Research Agency: U.S. Geological Survey, Department of Interior

Research Supervisor: Mr. C.E. Knox, District Chief, U.S.G.S.

D.P.W. Tech. Representative: Mr. C.E. Tuck, Bridge Division

This study is directed toward the collection and analysis of data to aid in the hydraulic design of highway drainage structures.

Progress during quarter

All stations, recording and crest-stage, were visited at least three times during the quarter. Discharge measurements were made regularly at the continuous-recording stations to help define stage-discharge relationship. There were no outstanding peaks observed during the quarter; however, some minor rises occurred. Routine maintenance and levels were done at most of the recording stations.

Final analysis has been made of the records from the ten continuous-type gages for the 1968 water year. Also peak-flow discharges for 1968 for the crest-stage gages have been computed. They are all to be included in Part 1 of the publication, "Water Resources Data for Massachusetts, New Hampshire, Rhode Island, Vermont - 1968."

Study No. R12-2 - Movement and Stability of Cuts and Fills

Research Agency: Massachusetts Institute of Technology

Research Supervisor: Prof. Wm. Lambe, Prof. of Civil Engr.

D.P.W. Tech. Representative: Mr. P.W.McHugh, Soils & Found. Engr.

Study Objectives: Obtain fundamental information on the reliability of techniques of predicting settlement, heave and stability of heavy embankments placed on thick deposits of soft soils.

Progress during quarter

The final embankment elevation (surcharge) was accomplished in Mid-May.

Instrumentation data was collected from settlement rods and platforms, hydraulic and electric piezometers, inclinometers, observation wells and total stress cells on schedules previously described.

Nine (9) of thirty-three (33) double tube hydraulic piezometers originally installed have either ceased to function or are not functioning properly at this time.

Four (4) of six (6) electric piezometers have also failed to respond properly.

An interim final report was published during the quarter summarizing all activities on the project during its three (3) year life. Detailed information is presented on instrumentation, and related work, at the Test Tunnel and North East Test Embankment.

Study No. R12-5 - Frost Susceptibility of Massachusetts Soils

Research Agency: Massachusetts Institute of Technology

Research Supervisor: Dr. Anwar E. Z. Wissa

D.P.W. Tech. Representative: Mr. P.W.McHugh, Soils & Foundation Engr.

Study Objectives: Develop a rapid laboratory testing procedure for determining the frost susceptibility of soils to permit the establishment of the approximate cut-off point between frost susceptible and non-frost susceptible soils.

Progress during quarter.

A sample of New Hampshire silt was studied and tested to determine the influence of backpressure and sample height on the pore water pressure drop during freezing in a closed system. Providing the backpressure is sufficiently high to insure that the sample remains saturated below the freezing point, the magnitude of the backpressure has no effect. Length of the sample does influence the measured drop in pore pressure.

Two (2) Massachusetts soils were tested during the quarter and showed large drops in pore pressure which suggests that they are probably frost susceptible. Boston Blue Clay was also tested and showed an even larger drop. Based on these results it appears that the pore pressure drop alone should not be used as the criterion but rather it should be coupled with the permeability in order to obtain a rational criterion. Permeability tests on these soils will be conducted in the near future.

PART II

CONCRETE CURB - EXPERIMENTAL

INTRODUCTION

The Massachusetts Department of Public Works has traditionally incorporated granite curb in preference to cement concrete curb in the design and construction of both federal and non-federal supported highways.

The Bureau of Public Roads however determined that states, including Massachusetts, has yet to provide convincing justification for use of granite curb to the exclusion of air-entrained concrete curbing. Available performance data for concrete curbing seem to relate only to either non-air-entrained concrete or to air-entrained concrete for which the amount of air entrained was not closely controlled and consequently varied considerably from the optimum percentage.

To permit unrestricted temporary use of granite curb on federally supported highway construction, the Department decided to establish an experimental construction program designed to provide an evaluation of alternate materials, furnish comparative costs and performance data that clearly indicate that one particular product is consistently less costly or qualitatively superior to all others in a degree sufficient to justify its exclusive use.

It is the intent of this report to briefly describe the scope of the experimental plan, the fabrication procedure, and plan of performance evaluation to permit documentation, conclusions and recommendations.

LOCATION

Three (3) sites on the Interstate highway system were selected to geographically represent environmental conditions identified as representative of the state and located at: I-195 New Bedford; I-95 Amesbury-Salisbury; I-91 West Springfield.

Cast-in-place and precast curb units were placed at these locations, at ramps, to weather the normally high concentrations of de-icing chemicals common to this area.

Placement dates were:

New Bedford	August 1967
Amesbury-Salisbury	June 1968
W. Springfield	September 1967

MATERIAL

A. Concrete

Class D Cement Concrete (Lehigh Type III Cement) was used throughout the precast phase.

B. Air Entrainment

Concrete design was based on optimum percentage of entrained air and construction operations closely controlled to assure that air was actually incorporated in the finished product.

Optimum air contents of 6% and 9% were fabricated in both precast and cast-in-place with a permissive tolerance of $\pm \frac{1}{2}$ %.

C. Protective Coatings

Sections of the precast and cast-in-place concrete curb, both 6 and 9% entrained air received separate protective coatings of either; Linseed Oil, Mineral Spirits Treatment; Silicone Treatment; Clear Concrete Sealer Treatment and the control section received no protective coating whatsoever.

Coatings were applied either at the fabrication plant or at the project work site.

SPECIFICATIONS

A. Slump

A slump test was made before each concrete placement. The specified 2"-3" consistency was achieved in all cases or the batch was discarded.

B. Air Content

Three (3) air content tests were taken on each batch; at the beginning; one-third the way through the pour and finally two-thirds (2/3) through the pour. Any reading outside the tolerance caused rejection of the batch.

PRECAST FABRICATION

Fabrication of the precast curb was performed by Northeast Concrete Products, a division of New England Concrete Pipe Corporation at Plainville, Massachusetts. Curb production began May 2, 1967.

Initial formulation was prescribed by the Department Standard Specification. The first six batches by the formulation produced unacceptable entrained air contents and the batches were rejected and discarded. Batch seven maintained the desired 6% content as determined by 3 separate air tests and accordingly was used to produce 14 curb units.

The following formulation proved satisfactory and was used throughout fabrication for $1\frac{1}{4}$ c.y. volume.

Cement	774	Lbs.
F. Aggreg.	1366	Lbs.
C. Aggreg.	2340	Lbs.
Water	35-40	Gals.
Air Ent. Agent	13	Ozs.

The water content was varied with aggregate moisture to produce a uniform consistency.

The 9% air content was achieved and maintained using a formulation comparable with the 6% with a reduction in the amount of aggregate to compensate for the volume increase of the air.

The following formulation worked well and provided satisfactory results in producing $1\frac{1}{4}$ c.y. volumes.

Cement	774	Lbs.
F. Aggreg.	1204	Lbs.
C. Aggreg.	2300	Lbs.
Water	35-40	Gals.
Air Ent. Agent	22	Ozs.

QUALITY CONTROL

Six (6) transfer cylinders and three (3) standard cylinders were made for strength tests of the curb for quality control purposes. Cylinders were steam cured with the curb units. Curing time was regulated by satisfactory breaking strength of the transfer cylinders.

CURING

Two hours after the concrete had been placed in the steel curb forms, the units were covered with a tarpaulin and steam applied to give a temperature rise of 40°F per hour to a maximum temperature of 130°F. Curing was maintained for a minimum period of 16 hours and extended until satisfactory breaking strengths were achieved from the transfer cylinders.

Steam was then discontinued to give a temperature drop of 40°F per hour to atmospheric temperatures, and the units stored under controlled conditions at the plant for approximately two (2) months.

Precast units were shipped to the project locations as ordered by the prime contractor and installed on gravel foundations and incorporated in the work.

CAST-IN-PLACE

Cast in place curb began at the New Bedford project and continued in the order of West Springfield and finally Amesbury-Salisbury. Forms for the curb ranged from steel to epoxy-faced plywood, all providing satisfactory finishes. The concrete formulation used was identical to that found satisfactory on the precast and generally provided predictable results in the parameters of air content, slump and temperature. Occasionally batches were rejected and discarded because of inabilities to meet contract specifications for air content. The concrete was placed in alternate forms, vibrated and cured as prescribed. Subsequent placement operations filled the alternate gaps and completed the cast-in-place operation.

The prescribed preservative coatings were applied by spray at the specified rates.

QUANTITIES OF CONCRETE CURB

Project No. 1

Cast in Place Concrete Curb	1130 L.F.
Precast Concrete Curb	1400 L.F.

Project No. 2

Cast in Place Concrete Curb	1600 L.F.
Precast Concrete Curb	1600 L.F.

Project No. 3

Cast in Place Concrete Curb	800 L.F.
Precast Concrete Curb	840 L.F.

Summary

Cast in Place		1130	
		1600	
		800	
	Total	3530	Lineal Feet
Precast		1400	
		1600	
		840	
	Total	3840	Lineal Feet

INSPECTION SCHEDULE

Each of the experimental sites shall be inspected semi-annually during the Spring and Fall to detect and analyze deterioration incurred by winter plowing and snow removal operations, effects of deicing chemicals used during maintenance operations and environmental affects from a geographic standpoint. Specific analysis will be directed toward identifying any inherent benefit in any of the variable air-entrained contents and variable protective coatings compared to the control section and also adjacent granite curb and edging.

It is expected that certain lengths of curb and edging will deteriorate at variable rates, depending upon the above conditions. Deterioration of the curb and ultimate destruction will obviously require replacement. The extent of replacement at the then current in-place construction cost will comprise the economic evaluation and concurrently identify advantages of particular preservative coatings and air contents.

CURRENT STATUS

Each of the curb sites have been inspected during the week of June 2, 1969 and the following observations noted:

1. I-95 - No discernable deterioration. Snow removal operation during the past winter incurred no mechanical scars or damage to the curb. No deterioration was identified from deicing agents or environmental condition. There was no significant difference noted between various preservative coatings or variable entrained air contents.

2. I-95 - Curbing moderately damaged at both arris line and curb-face by snow removal and plowing operations. Deterioration not evidenced from environmental or geographic parameters but accelerated deterioration is anticipated because of physical damage. There was no significant difference noted between various preservative coatings or variable entrained air contents.

3. I-91 - Curb displays no physical damage and aesthetically appears very good. There was no significant difference noted between various preservative coatings or variable entrained air contents.

Additional data and information on the experimental nature of this project is available from the Research and Materials Engineer.

John J. Hannon
Research Engineer

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
RESEARCH AND MATERIALS SECTION

QUARTERLY REPORT ON NEW PRODUCTS

EPORT NO. 3

DATE: October, 1969

.E. REF. NO.	PRODUCT NAME	MANUFACTURER	USE	REMARKS
9-2-1-1	Gelvatol	Monsanto Company Pr. & R Division	Conc. Additive for Adh. & Bond	Long Term Testing.
9-3-10-17	Epi-Rez	Celanese Resins	Bridge Overlay	Long Term Testing.
9-3-10-1	Guardkote	Shell Oil	Bridge Coating Epoxy-Resin	Long Term Testing Field Applic. Boston St. Bridge
9-3-10-2	Rambond	Ramchem Company	Epoxy-Bonding Agent for Conc. Bridge Decks	Long Term Testing. Field Applic. Middle St. Bridge Weymouth
9-3-8-4	PRC-445-440	Products Research Company	Non-Skid Overlay	Long Term Testing Field Applic. Middle St.Bridge Weymouth
9-3-8-5	Ritza-Anti Glare	KOCH Division Schmidt Industries	Screen for Median Strip	Long Term Testing
9-3-8-6	Catadots	Cataphote Corp.	Roadway Delineation	Long Term Testing
9-3-7-3	Rubatex	Rubatex Corp.	Joint Sealer	Long Term Testing
9-3-10-9	Dow SM-100	Dow Chemical Company	Bridge Deck Restoration	Long Term Testing

MS-640

QUARTERLY REPORT ON NEW PRODUCTS

REPORT NO. 3

DATE: October 1969

P.E. REF. NO.	PRODUCT NAME	MANUFACTURER	USE	REMARKS
9-1-9-2	Nordel	E.I.du Pont de Nemours Co.	Membrane Waterproofing	Long Term Testing Field Application S.E. Expressway
9-1-9-3	Nexus	U.S. Steel Corp.	Membrane Waterproofing	Long Term Testing Field Application S.E. Expressway
9-3-8-8	Royal Seal	Uni Royal, Inc.	Synthetic Rubber Membrane Water-proofing	Long Term Testing Field Application S.E. Expressway
9-4-15-1	DCA 70	Union Carbide Corp.	Soil & Dust Erosion Control	Long Term Testing
9-3-7-5	Polytite	Sandell Mfg. Co.	Joint Sealer	Long Term Testing
9-3-15-2	Fascal 900	Fasson Products	Decal Material	Long Term Testing
9-3-15-3	Cycolac	Safety Guide Products	Signs	Long Term Testing

PART IV

RESEARCH IMPLEMENTATION

The University of Massachusetts in cooperation with the U. S. Dept. of Transportation, Bureau of Public Roads, and the Commonwealth of Massachusetts, Department of Public Works has been engaged in a five year program entitled Roadside Development as outlined earlier in this report under Part I, Sponsored Research.

The results to date, in some projects, namely R5-2 Development and Evaluation of Low Maintenance Herbaceous Material for Plantings Along Highways and R5-3 Establishment of Woody Plants Along Roadsides to Reduce Functional Maintenance Costs have proved to be ready for adaptation to actual highway conditions.

The Department of Public Works, Maintenance Section has, as a result of eight successful selected plantings of the material Crown Vetch producing excellent results, included the planting of 1000 Crown Vetch in $2\frac{1}{2}$ inch peat pots in each of the eight districts. These plantings will be carried out in eight separate Maintenance Contracts for Erosion Control and Reduction of Mowing. In addition, the Department will use their own Maintenance Forces to plant 500 Crown Vetch in $2\frac{1}{2}$ inch peat pots in each of the eight districts. A further step is that in each of the eight districts the Department will plant 15 pounds of Crown Vetch seed.

Testing, in the control of weeds in conspicuous areas, using the product, Casoron (dichobenil) has progressed so well that the Department is purchasing enough material to treat two acres in each of the eight Districts. This material will be used as recommended by the University of Massachusetts and under the direct field supervision of the University and personnel from the vendor.

This program of implementation of research results to maintenance programs will be followed closely and reported on at a later date.

Joseph L. Beasley
Highway Landscape Supervisor